PREFACE

This report is the culmination of 4 years of study on anadromous fish (principally the salmonids) and habitat of the Situk River, neighboring watersheds, and Russell Fiord, Alaska. The research from 1988 to 1990 was organized and funded through Memorandum of Understanding 88023 between the National Marine Fisheries Service Auke Bay Laboratory, the Alaska Department of Fish and Game, and the U.S. Forest Service to predict the effects of flooding on fish and habitat from overflow of Russell Fiord into the Situk River. This report satisfies the memorandum of understanding requirement of a written report. Results of related research in 1987 by the Auke Bay Laboratory and the U.S. Forest Service are included. This is an informal report; however, portions have been published and are cited as such.

The first major section of this report following the Executive Summary provides background information on the study area. It presents a history and description of the Hubbard Glacier, Russell Fiord, and the Situk River watershed; describes probable physical changes after the flooding, the status of fish stocks and fisheries, and the life histories of anadromous fish species that will be impacted by flooding; and presents a general evaluation of Situk River productivity. The Assessment of Fish and Habitat section presents 10 studies: 9 concerning the Situk River and adjacent watersheds, and 1 pertaining to Russell Fiord. Based on conclusions from the studies and available information, the final two major sections discuss the potential effects of flooding on fish and habitat, and identify possible restoration strategies and research needs.

EXECUTIVE SUMMARY

PURPOSE OF STUDY

This document presents the results of 3 years (1988-90) of cooperative research by the National Marine Fisheries Service (NMFS) Auke Bay Laboratory, Alaska Department of Fish and Game (ADF&G), and United States Forest Service (USFS) on the potential effects of flooding on fish and habitat from overflow of Russell Fiord into the Situk River and neighboring watersheds near Yakutat, Alaska. The study was organized and funded through Memorandum of Understanding (MOU) 88023 between NMFS, USFS, and ADF&G. Research by NMFS and USFS in 1987 is also presented.

The Hubbard Glacier is expected to advance and permanently dam Russell Fiord by the year 2000; the newly formed "Russell Lake" would fill in 7-14 months and then overflow into the Situk River. Flooding would significantly alter Russell Fiord, the Situk and adjacent rivers, and the Situk estuary. The Situk River would change from a clear, stable, primarily groundwater-fed river to a large, unstable glacial river. Average flow would increase by a factor of 37. The river would become cooler and turbid from glacial runoff. The estuary would probably become larger, more turbid, and less saline. Newly formed "Russell Lake" would be about 200 km^2 in size and would have a surface lens of fresh water. Rising water would inundate lower sections of over 100 fiord streams.

Flooding could seriously jeopardize important fisheries in the Yakutat area. Annual returns of the five Pacific salmon species and steelhead to the Situk River are about 450,000 fish of which about one-third are harvested in commercial, subsistence, and sport fisheries. Commercial and recreational fisheries combined are worth approximately $3 million annually to the Yakutat economy.

Research focused on the probable effects of flooding on the life history, habitat, and abundance of adult and juvenile anadromous salmonids. Objectives were to 1) determine the location and use of spawning and rearing habitat; 2) determine characteristics and habitat requirements of stocks with uncommon life histories; 3) predict effects of flooding on habitat and fish production; and 4) suggest strategies to restore fish and habitat that could be impacted by flooding.

ASSESSMENT OF FISH AND HABITAT

Distribution and habitat use of adult sockeye, chinook, and pink salmon in the Situk River were studied in 1988 to determine residence time and number of adults that spawn in the (predicted) flood zone. Similar data were obtained for other species from reports and consultation with biologists. Sockeye and chinook were tagged in the lower Situk River and tracked to spawning areas. Median residence time in the flood zone was 17 days for sockeye and 30 days for chinook. The maximum percentage of adults in the flood zone at any given time differed among species, ranging from less than 10% for fall steelhead trout to nearly 90% for chinook. About one-third of all salmonids spawn within the flood zone: 5% chinook, 5% sockeye, 25% coho, 40% pink, 25% spring steelhead, 0% fall steelhead, and 90% Dolly Varden. All adults use similar migration habitat but different spawning habitat.

Distribution and abundance of juvenile salmonids in summer were estimated in the Situk and Lost Rivers to determine the number of juveniles that rear in the flood zone. Fish density and habitat characteristics were measured in 42 stream reaches in the summers of 1987-89; lakes were not sampled. Fish densities were extrapolated, using the USFS Channel Type Classification System, to the entire Situk and Lost River drainages. About 70% of the total juvenile salmonids in the Situk and Lost Rivers (excluding lakes) reared in the flood zone in summer: over 90% of sockeye, chinook, and Dolly Varden; 70% of coho, and 45% of steelhead. Coho were the most abundant and were present in all study reaches, whereas chinook occurred almost exclusively in the main-stem Situk River. Sockeye were the least abundant and were primarily in Old Situk River. Steelhead occurred in 75% of the study reaches; 40% reared in the West Fork Situk River. Dolly Varden were the second most abundant salmonid—90% reared in Old Situk River.

To determine seasonal use of the main-stem Situk River by juvenile salmonids, fish density and habitat were sampled at four sites in the main stem about every 2 weeks from May to September and in November 1989. Coho, steelhead, and Dolly Varden were common in the main stem from May through November, and sockeye were present from May to late July. In late November, coho and steelhead fry (age < 1) were still common, but parr (age ≥ 1) were virtually absent, except for Dolly Varden. Fry often used channel edges with little cover, but parr primarily used willow edges and pools with abundant cover. Fish densities were higher in the upper main stem than in the lower main stem, probably because of warmer water and more abundant food near the Situk Lake outlet. Thus, the main-stem Situk River is an important summer rearing area for salmonids. The lower river also is an important staging area for fish acclimating to seawater while migrating to sea.

Juvenile chinook and sockeye in the Situk River were studied to document their uncommon "ocean-type" life history. Most chinook and about 5% of juvenile sockeye in the Situk River (including lakes) are ocean type—migrate to sea their first year without wintering in fresh water. Juvenile chinook were sampled at 55 sites in the Situk River and adjacent watersheds from 1987 to 1989. Chinook primarily occupied main-stem habitats (channel edges in spring, pools and willow edges in summer). Chinook migrated downstream in two phases: a spring dispersal of emergent fry, and a summer migration of presmolts. Chinook marked in the upper river in late June and July were recaptured 20 km downstream in the lower river in late July. Marked chinook remained in the lower river for up to 34 days. Mean fork length of chinook in the lower river increased from 40 mm in May to 80 mm in early August. By late August, chinook had emigrated from the lower river, presumably to sea, at a size of about 80 mm. Fish this size had the physical appearance of smolts and, based on seawater-challenge tests, could tolerate seawater.

To determine the life history of ocean-type sockeye, several sites in the upper and lower main-stem Situk and Old Situk Rivers, and in the Situk estuary were sampled in 1987-88. Two separate migrations of sockeye fry were apparent: an early migration of newly-emerged fry into the estuary in March and April and a later migration of larger sockeye from the lower river in May and June. Neither group remained in the estuary or lower river for long; most early migrants disappeared from their primary habitat (tidal sloughs) by mid-May, and most later migrants spent less than 3 weeks in the lower river and estuary. Size was a determining factor in seaward migration. Fry left rearing areas throughout the river and estuary and moved seaward as their size approached 50 mm, the threshold size determined by seawater-challenge tests for 100% survival.

To enumerate migrant juvenile salmonids and evaluate winter habitat, a weir was constructed in 1989 on Old Situk River near its confluence with the Situk River. An estimated 26,200 coho, 7,000 sockeye, 500 steelhead, and 5 chinook smolts migrated from Old Situk River. An estimated 93,000 age-1 coho parr emigrated from Old Situk River and probably reared in the main-stem Situk River until smoltification. An estimated yield of 45 salmonids/100 m^2 (parr and smolts) demonstrates that Old Situk River is important winter habitat.

To determine the yield of salmonid parr and smolts from inside and outside the flood zone and location of winter habitat, rotary-screw traps were fished in the upper and lower main-stem Situk River in 1990. Total smolt yield from the Situk River watershed was 893,000 sockeye (including 128,000 ocean type); 168,000 coho; 67,000 chinook; and 26,000 steelhead. About 30% of the smolts migrated from the flood zone. The percentage of smolts originating from the flood zone differed among species and stocks, ranging from 100% for ocean-type sockeye to 0% for steelhead. Natural smolt mortality during downstream migration through the main stem was estimated to be about 25% and was attributed to predation.

To assess importance of the Situk estuary for juveniles, the Situk Estuary was sampled in spring and summer of 1987-88. The estuary serves as a productive spring and summer rearing area for salmon fry, particularly ocean-type sockeye, and is a migration corridor for anadromous fish entering or leaving fresh water. The estuary also provides habitat for at least 11 species of marine fish and numerous invertebrates, including Dungeness crab.

Summer distribution of juvenile salmonids in streams entering Russell and Nunatak Fiords was determined to evaluate potential loss from flooding. Rearing salmonids occurred in only 30 of 102 streams sampled. Juvenile Dolly Varden were in 30 streams; coho were in only 9 streams. Streams without juvenile salmonids were usually short and steep and had poor spawning and rearing habitat. Thus, Russell and Nunatak Fiord streams are generally unproductive and do not contribute substantially to fish production in the Yakutat area.

Five baseline sites were established to characterize juvenile salmonid abundance and habitat so that changes after flooding could be evaluated. Sites (three inside and two outside the flood zone of the Situk and Lost Rivers) were sampled in summer and fall from 1987 to 1990. Variables measured include fish density, amount of large woody debris, pool-rifle ratio, stream size, and water temperature. Coho were at all sites and were the most abundant salmonid; sockeye were least abundant and were at only two sites. Densities were generally lower in fall than in summer and varied annually in both summer and fall.

PREDICTED EFFECTS OF FLOODING

After Hubbard Glacier impounds Russell Fiord, most spawning and rearing habitat in Russell Lake streams and about 70% of the Situk River would be flooded. Overflow from Russell Lake would severely impact Old Situk River and the main-stem Situk River downstream from its confluence. Old-growth forest in the floodplain would be destroyed, and log jams would intensify flooding. Stream gravel would be scoured, shifted, and often filled with fine sediment. The greatest impact of flooding on fish and habitat would be from initial flooding or from successive flooding events caused by the formation and destruction of glacial dams. Habitats would be unstable for several years as the river channel adjusts to increased flow and changes in sediment and debris.

In the Situk River, flooding would probably affect juvenile salmonids more than adults; impacts would be greatest in summer because of the abundance of juveniles in the flood zone. However, some juveniles are in the flood zone all year and would be affected anytime flooding occurred. Most affected would be coho, ocean-type sockeye, chinook, and Dolly Varden. Old Situk River was identified as important juvenile winter habitat and would be severely impacted by flooding.

The uncommon ocean-type life histories of sockeye and chinook salmon in the Situk River may be jeopardized by flooding because of changes in their specific requirements. In Alaska, most sockeye and chinook rear at least 1 year in fresh water. Cooler water after flooding could reduce growth and increase freshwater rearing time of ocean-type fish from 4-6 months to 1 or more years.

The severity of effects of flooding on adult salmonids in the Situk River would depend on timing and duration of floods; however, all species will be affected because they all migrate through the flood corridor. Most species primarily spawn upstream of the flood zone and their spawning habitat would not be directly affected; however, 40% of pink salmon spawn inside the flood zone. Displaced pink salmon may compete with other species for spawning habitat outside the flood zone. Ocean-type sockeye also would be severely impacted because nearly all spawn in the Old Situk River, a major corridor for flood waters.

After the Situk River stabilizes, abundance of some species could increase to higher than pre-flood levels because of the formation of new habitats (e.g. secondary floodplain channels, sloughs). For instance, juvenile chinook and sockeye rear successfully in cooler glacial rivers and may benefit from the increased rearing area. If the amount of groundwater increases, there could be benefits to all fish, particularly ocean-type sockeye.

Salmonids in Russell Fiord streams would be severely affected if the Hubbard Glacier dams Russell Fiord. Most rearing and spawning habitat in fiord streams would be flooded, but the new lake could provide extensive rearing habitat. Although access via Yakutat Bay would be eliminated, entry would become available via the Situk River.

RESTORATION STRATEGIES

Restoration efforts to offset the loss of fish and habitat in the Situk River should concentrate on enhancing the recovery of fish stocks or habitats that may recover too slowly or not at all. Appropriate restoration strategies could be implemented after Hubbard Glacier dams Russell Fiord because Russell Lake would take up to 14 months to fill. Costly restoration efforts however, should be limited until after the initial years of flooding to evaluate the response of fish populations and habitat.

Restoration efforts should concentrate on species or stocks considered at high risk (i.e. depressed abundance, high fisheries value, or uncommon life history). Steelhead in the Situk River were considered at the highest risk and have the greatest need for restoration because of their currently depressed population. Steelhead should be managed now to increase their numbers to the historic average to help them withstand the impacts of flooding: a stream management plan should be implemented to prevent further damage to fish habitat; woody debris cutting or log jam removal should be prohibited; and the number of boats and size of outboard motors limited on the Situk River. Restoration for chinook, ocean-type sockeye, and coho should consist of developing new rearing and spawning habitat. Management of the pink escapement may alleviate potential problems caused by an increase in the number of fish spawning outside the flood zone.

Possible restoration projects include construction of ground-water fed spawning channels and rearing ponds, construction of egg-incubation facilities, enhancement of Russell Lake, and changes in fisheries management. Potential restoration sites include groundwater sources near Greens Pond, Milk Creek, Ophir Creek, Cannon Beach Creek, and the Yakutat airport. Diversion of floodwaters and clearing of trees from the floodplain should not be done because of potentially severe damage to fish habitat.

RESEARCH NEEDS

Before flooding, pilot studies should be done to evaluate the effectiveness of the identified restoration strategies. The carrying capacity of the Tawah Creek drainage should be determined before restoration projects are initiated there. Further evaluation of lakes in the Situk and Lost River drainages would help determine their carrying capacities and whether lake enhancement would be warranted. Groundwater sources should be evaluated to determine areas in the Situk River watershed where flow is sufficient to provide year-round water for enhancement or restoration projects. Although restoration in Russell Lake will be difficult because of its wilderness classification, the feasibility of rearing sockeye there should be studied after flooding. Smolt yield should be determined again to establish a baseline for smolt yield and to quantify smolt predation and identify its source. To better predict the effects of increased adult salmon spawning outside the flood zone, the effects of stock interaction should be studied. The contribution of rearing ponds to smolt production should be evaluated before ponds are enhanced or created. Fish populations and habitat should be monitored after flooding to evaluate restoration effectiveness.